DOCUMENT RESUME

ED 348 171 IR 020 784

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TITLE The Efficacy of Using the Visual Arts To Teach Math and Reading Concepts.
PUB DATE Apr 92
NOTE 27p.; Paper presented at the Annual Meeting of the American Educational Research Association (73rd, San Francisco, CA, April 20-24, 1992).
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Art Education; *Concept Teaching; *Elementary School Students; Grade 5; Integrated Curriculum; Interdisciplinary Approach; Intermediate Grades; *Mathematics Achievement; *Reading Achievement; *Visual Arts

ABSTRACT

This study investigated the use of art lessons to enhance the comprehension of specific concepts taught in a school curriculum. Reading and mathematics achievement measures were administered as pre- and posttests to 87 fifth graders. Students in the treatment group were taught art lessons by an art teacher. In these lessons, the concepts of area, volume, perimeter, congruency, pattern, and sequence were stressed. Students in the comparison group were taught these concepts by their classroom teachers during the regular mathematics and reading periods. Results indicated that students in the treatment group exhibited significantly higher mean posttest scores for the concepts of pattern and area, and combined posttest scores across the six concepts, than students in the comparison group. For all concepts except perimeter, students in the treatment group showed a greater gain than students in the comparison group in test scores between pre- and posttest. A 33-item reference list is provided. Sample lessons that use art in the teaching of concepts are appended. (BC)

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The Efficacy of Using the Visual Arts to Teach Math and Reading Concepts

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Round Table Discussion
American Educational Research Association
Annual Conference
San Francisco, CA
April, 1992

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The Efficacy of Using the Visual Arts to Teach Math and Reading Concepts

by Leslie Willett, Hollins College and David Parks, Virginia Tech

The acquisition of cognitive skills and their relationship to the arts has not been deeply probed and is an area needing additional inquiry and research. This quasi-experimental study was designed to investigate the hypothesis that specially designed art lessons can be used as a medium to enhance the comprehension, transfer, and retention of specific concepts traditionally taught in the basic school curriculum. The concepts selected were ones measured on standardized tests that coincided with those addressed in an elementary school art curriculum. In addition to measuring acquired knowledge, students' dominant learning modalities were assessed to determine if the predominant type of instruction (auditory, visual, or kinesthetic/tactile) influenced the amount of knowledge gained by students based on their dominant learning modalities.

Integrating or linking disciplines to enhance learning within the curriculum has been suggested by philosophers, educators, and psychologists (Bassett, 1969; Bruner, 1961; Dewey, 1931; Eaton, 1985; Field, 1970; Lowenfeld & Brittain, 1987; McFee, 1961; Perkins & Salomon, 1988; Read, 1945). Art is an integral part of many other disciplines and can serve as a natural mode of integration by linking content areas. Read (1945) wrote of the "value of art as [an] educative medium" (p. 14) and stated that it should be the "fundamental basis of education" (p. 71). Field (1970) elaborated on Read's work saying that it "makes a case for art as a total means of education" which has not been "taken so seriously as perhaps it deserves" (p. 55). Eaton (1985) stated that art can be used as a vehicle for carrying content to be learned.

Silver (1978) found that learning disabled and hearing-impaired children

demonstrated significant improvement in their ability to order sequentially, form groups, and organize spatial relationships as a result of structured art lessons. "The time may . . . be right for serious consideration of the role of art in developing cognitive skills" (p. 119). Results of a study by Greene and Hasselbring (1981) with children who were prelinguistically and profoundly hearing-impaired strongly suggest that linking visual art activities that combine visual, linguistic, and tactile modes to target language concepts results in greater concept attainment than teaching the same concepts without art. They concluded that art should become an integral part of the curriculum for hearing-impaired children, and they suggest more empirical support for "whether art can serve as a successful and generalized teaching mechanism for the hearing impaired" (p. 36).

Children often have a conceptual understanding that is greater than they can express either verbally or in writing. By incorporating art as a link or mode to expression, children can often "say" what they know in a non-verbal way. In a study conducted by the researcher (Willett, 1987), a teacher reported the following incident which had occurred in her class:

> A few years ago I had a student who was in special classes and could not read, and really could not do anything written that we did. . . . We were studying Virginia history and I asked my class to draw something that they were interested in and then tell me about it. The student drew a very detailed picture. I think he had almost everything that we'd covered on Virginia history on a large poster, and I was amazed that he had taken in that much and was able to put it out on paper. Not written, but in an art form. (p. 31)

By combining art and social studies, the child was able to demonstrate his conceptual understanding in a less traditional way than is normally used in school. If his teacher had not allowed the child to express what he knew in a non-written mode, she would not have realized the depth of his comprehension. As Silver (1978) stated, "Particularly for the child deficient in language skills, drawing and painting

pictures about experiences can serve to integrate new information and demonstrate what has been learned" (p. 19).

Modality-based instruction is designed around the belief that teaching methods are most effective when compatible with children's learning modality strengths (Milone, 1981). This instructional procedure has had wide appeal over the past two decades among educators who subscribe to the belief that modality-based instruction positively affects achievement. Although people learn through all their senses, the visual, auditory, and kinesthetic senses are most used in formal education. Many researchers (Barbe & Swassing, 1979; Cornett, 1983; Dunn & Dunn, 1978) report that some people learn better by hearing information, some by seeing examples or watching demonstrations, and others by physical participation or hands-on manipulation of materials. Barbe and Swassing (1979), Bruno (1982), and Milone (1981) suggested that instruction is more effective if teachers speak to auditory learners, show pictures to visual learners, and demonstrate for tactile learners. Dunn and Dunn (1975) reported increased achievement and motivation when learning and teaching styles were matched.

Lowenfeld (1945) described the idea of visual and haptical aptitudes of people. The visually-minded person relies on visual experiences to interpret and learn from the world. The haptically-minded person, in contrast, reacts as a blind person dependent on touch and kinesthesis for interpreting and learning. Ast (1981) hypothesized that the Lowenfeld tests for identifying visual/haptic types might be used as variables in studies on children's learning in formal school settings. She questioned if children identified as haptics might be at a disadvantage in acquiring certain academic skills in traditional classrooms. In her study of 243 children, she found approximately 42% to be haptic learners. Others were visual or indefinites. This coincides with results

from studies by Bruno (1982), Lowenfeld (1945), and Read (1945). Armstrong (1988) reminds us that traditional instruction addresses linguistic and logical-mathematical learners. Those with other dominant learning modalities are not taught in the ways in which they learn best.

When learners are exposed to instruction which uses multiple modes to transmit information, it is more likely to be comprehended and retained. Teaching selected concepts through art is a method that can be used to incorporate auditory, visual, and kinesthetic learning modes in one lesson. In art lessons learners hear directions given by the teacher. They see results of the instruction by viewing what the teacher demonstrates, models, and exhibits. After receiving verbal and visual instruction, students immediately work on a solution to a similar problem by manipulating materials to create a product. According to Bassett (1969), "We know, theoretically, that there is a value in applying knowledge as soon as it is acquired. . ." (p. 34). By using new information to solve problems closely after instruction, concepts may be more readily imprinted on the brain. Or as Gardner (1973) stated, "Careful viewing followed by making may result in a more accurate comprehension than attending to the symbolic description" (p. 158).

Various authors (Bassett, 1969; Guilford, 1968; Hunter, 1971; Murphy & Jones, 1976; Perkins & Salomon, 1988) discussed the idea of transfer of knowledge and skills from past learning to present situations. Transfer involves extending knowledge beyond learning in a particular incident to another or different context. Perkins and Salomon (1988) recently reported some discouraging evidence concerning the way transfer occurs in school. They believe that transfer does not happen as often as educators would like to think. They have said that while transfer <u>can</u> occur, it should not be left to chance. Hunter (1971) has stated that "teaching for transfer"

is the first and last goal of all teaching. A student's ability to transfer previously learned knowledge "to a new situation is the heart and core of all creativity, problem solving, and critical thinking" (p. iii). Teacher planning, according to Hunter, is the critical element in teaching for transfer. It makes the difference between hoping transfer will occur and seeing that it does.

Silver (1978), who defined "transfer" as the ability to generalize from one experience to another, stated his belief that art experiences can provide opportunities for the transfer of learning. To ensure that students retain information acquired from their studies, Rush (1987) suggested that lessons should be repeated in contexts different from the initial way the lesson was presented so that "real-world and art images interlock conceptually" (p. 207).

O'Brien (1971), the developer of the Learning to Read through the Arts program designed to employ visual and performing arts as a core for learning, had positive results with students' reading and writing scores, but Murphy and Jones (1976) reported that when researchers attempted to establish the theory that competence in visual perception and involvement in producing art aided in academic achievement, results were inconclusive. Cohen (1968) also reported inconclusive results from a study using art as a medium to teach conceptual skills thought to be important for reading and math. He stated that if an attempt is made to shape academic skills using arts as media, "undivided attention" must be paid to the achievement of target academic behaviors. It should not be assumed that transfer will occur. Forseth (1976) examined the effect of art activities on attitude and achievement in mathematics for fourth-grade children. Results indicated an increase in positive attitude toward mathematics for the math/art treatment group, but no significant difference in achievement. Broudy (1979) warned that "one must examine carefully whether the facilitating powers of art experience on other phases of schoolwork are

anything more than a hope and a plausible conjecture" (p. 347).

Methods/Techniques/Data Source

The methodology used in the study was a pretest-posttest quasi-experimental design. Science Research Achievement (1979) subtests and a custom-made test using questions from an item bank of the Academic Instructional Measurement System (1987) were used as pre- and posttests. These tests were used to determine if the treatment group was able to learn selected concepts through art instruction as well as the comparison group who was taught in a traditional manner.

Subjects in the study consisted of 87 fifth-grade students who attended an elementary school in a middle-sized southwest Virginia city. The school was located in a low to middle class socioeconomic neighborhood. The student population was 68% black and 32% white. Students were heterogeneously grouped and assigned to four different classrooms. Teachers in the study consisted of an art teacher and four classroom teachers. Each of the four intact classrooms of learners was randomly assigned to either the treatment or comparison group. Two classrooms of students were in each group.

After the subtests on reading and mathematics were administered to all students, students in the two treatment classrooms were taught art lessons by the art teacher. The concepts of area, volume, perimeter, congruency, pattern, and sequence were stressed. The concepts were not addressed by their classroom teachers. The comparison classes were taught the selected concepts by their classroom teachers during the regular math and reading periods.

As the groups had to be studied in tact, an analysis of covariance was used to test the difference in means between the posttest scores after the initial difference in pretest scores was taken into account. ANCOVA was conducted for each

dependent variable and for the total score calculated across all dependent variables.

Greater concept attainment was expected by linking targeted concepts to specially-designed, multimodal visual art lessons. The lessons were designed and taught to assist learners in making connections among disciplines. By involving children in an integrated curriculum, deeper interest, greater conceptual understanding, and the transfer of knowledge were expected to occur. To determine if transfer occurred, test items for the targeted concepts were analyzed. If students were able to transfer specific knowledge gained from art lessons to a more general context found in the test items, then transfer was assumed to have occurred.

To determine if the congruence of the dominant teaching and learning modality affected concept attainment, all students in the treatment and comparison groups were individually administered the Swassing-Barbe Modality Index (SBMI) designed to identify the individual's most efficient learning mode. A Teacher Behavior Checklist, designed by the researcher was used to measure the percentage of time auditory, visual, kinesthetic/tactile and mixed modalities were emphasized in teaching by the art teacher and the classroom teachers. An analysis of covariance was conducted to determine if the amount of knowledge gained by students based on their individual learning modalities was affected by the method of instruction they received.

Results

The analyses of covariance (Table 1) indicated that in the combined achievement scores across all concepts there was a significant difference in adjusted means between the comparison and treatment groups in favor of the treatment group. For the individual concepts, there was a significant difference between adjusted posttest means for the concepts of pattern and area in favor of the treatment group.

From the results of this study, students whose teachers presented the selected

Table 1

Summary of Analyses of Covariance

	Treatment			Comparison				
	n	M	SD	n	M	SD	F	p
Area	47	1.54	.26	40	1.45	.24	3.74	.056*
Volume	47	1.21	.28	40	1.17	.27	.46	.50
Perimeter	47	1.81	.18	40	1.84	.16	.80	.37
Congruency	47	1.97	.09	40	1.93	.14	1.95	.17
Pattern	47	1.96	.09	40	1.87	.23	6.00	.02*
Sequence	47	1.81	.18	40	1.75	.23	2.41	.12
Total	47	1.71	.12	40	1.67	.11	6.95	.01**

*$p < .05$. **$p < .01$.

Note. The covariate was the corresponding pretest score in each analysis. The number of questions for each concept was: area (4), volume (4), perimeter (5), congruency (4), pattern (4), sequence (7), and total (28).

concepts using either traditional or treatment methods improved in their knowledge of those concepts, but when art was used as a vehicle to teach concepts, a significantly higher mean posttest score across concepts resulted for the treatment group. In the treatment group, when art was used as a link between certain mathematical and reading concepts, it appears to have enhanced learning.

Results of the analyses of covariance (Table 2) revealed there were no significant differences in the amount of knowledge gained by students based on their individual learning modalities and type of instruction received. Regardless of their dominant learning modalities, children as a group scored significantly higher on the posttest when taught using the specially designed art lessons.

With respect to transfer of specific knowledge learned in art lessons to the more general knowledge on the test, it was found that the treatment groups made greater gains from pretest to posttest than the comparison groups (Table 3). On each concept (area, volume, congruency, pattern, and sequence), students in the treatment group improved their posttest scores over their pretest scores by more than the comparison group. Only on the concept of perimeter did the comparison group score higher.

Table 2

Summary of Analyses of Covariance

	V (n=24)		A (n=14)		K (n=13)		VA (n=14)		VK (n=9)		AK (n=6)		VAK (n=7)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Area	1.50	.25	1.53	.27	1.58	.28	1.46	.21	1.37	.22	1.47	.29	1.47	.24
Volume	1.17	.30	1.20	.37	1.32	.24	1.08	.15	1.16	.21	1.25	.39	1.13	.09
Perimeter	1.83	.20	1.86	.12	1.88	.13	1.72	.22	1.83	.12	1.89	.16	1.75	.15
Congruency	1.93	.13	1.93	.16	1.93	.11	2.00	.00	1.97	.08	1.96	.10	1.96	.09
Pattern	1.93	.18	1.94	.15	1.86	.28	1.90	.16	1.91	.18	2.00	.00	1.96	.09
Sequence	1.79	.26	1.72	.21	1.80	.17	1.78	.17	1.84	.24	1.82	.17	1.73	.18
Total (N=87)	1.70	.13	1.71	.14	1.72	.09	1.66	.06	1.68	.10	1.74	.15	1.66	.07

Note. The explanation for abbreviations is as follows. V = visual; A = auditory; K = kinesthetic; VA = visual/auditory; VK = visual/kinesthetic; AK = auditory/kinesthetic; VAK = visual/auditory/kinesthetic.

Table 3 Comparison of Pretest and Posttest Scores From the SRA Achievement Series and the AIMS Tests to Determine Transfer of Knowledge of Concepts by Concept

	Comparison (n=40)			Treatment (n=47)		
Concept	Pre	Post	Diff	Pre	Post	Diff
Area	1.37	1.45	.08	1.35	1.53	.18
Volume	1.16	1.20	.04	1.10	1.18	.08
Perimeter	1.72	1.84	.12	1.74	1.81	.07
Congruency	1.91	1.94	.03	1.84	1.96	.12
Pattern	1.85	1.87	.02	1.89	1.96	.07
Sequence	1.61	1.74	.13	1.64	1.82	.18
Total	1.60	1.67	.07	1.59	1.71	.12

Conclusions

The conclusions of this study lead to considerations and recommendations that may be helpful to educators attempting to improve teaching strategies which enable students to obtain and retain more knowledge from instruction. When students in this study were taught selected concepts using either traditional or treatment methods, as a whole they improved their knowledge of the concepts. The study revealed that students who were taught the concepts by the treatment (art) method increased their knowledge, overall, more than the students who were taught traditionally. The data indicate that the integration of art activities into mathematics and reading can enhance the learning of specific concepts. This finding supports the work of Read (1945), McFee (1961), Field (1970), Silver (1978), Eaton (1985), and Steger (1988) who report that art can and should be used as a vehicle for carrying content to be learned, for it serves as a connection or link between disciplines. This linking of information in a student's mind through auditory, visual, and kinesthetic involvement helps students understand and learn more information from their lessons.

Classroom teachers should become more aware of the necessity for increasing their use of visual and kinesthetic approaches in their teaching. Students in this study, regardless of their dominant learning modalities, learned more from the treatment teacher who employed a more multimodal teaching style. As no significant differences were found in achievement based on the match between dominant learning modalities and modalities emphasized by teachers during instruction, additional research is recommended to ascertain if modality-based instruction influences learning as much as believed by some researchers and educators.

Guilford (1968), Bassett (1969), Silver (1978), O'Brien (1971), Hunter (1971), Perkins and Salomon (1988), and others have emphasized the importance of teaching for transfer. When teachers guide students to see connections between subject

matter and to use skills and knowledge in different contexts, transfer occurs more readily for them. Educators should plan and teach for transfer to other contexts as they design and present integrated lessons. This strategy will enable students to remember, understand, and apply content more easily.

Educators must begin to look upon art as a more important part of the curriculum, not only because it offers a means for learning about one's cultural heritage, a means of communication, and a means of creative fulfillment, but also because it offers a tool to facilitate teaching and learning. If it is a natural mode of integration for children as Read (1945) stated, then it should be linked with other disciplines to facilitate learning. Children generally enjoy art and readily participate in it. Integrating art with a less popular discipline, without jeopardizing the content of either, can be a successful teaching strategy. Additional lessons, other than those designed for this study, should be constructed by art and classroom teachers working together to facilitate students' learning of concepts through art. Based on the results of this study, the strategy of using art as a vehicle for teaching selected concepts appears to be an appropriate one to use to enhance learning.

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SAMPLE LESSONS
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CONCEPT AREA, PERIMETER, VOLUME

SUBJECT City planning, constructing GRADE LEVEL 5

PROCESSES Determining area, perimeter, and volume of constructed shapes and forms
Constructing simulated elements of city
Employing elements of art and principles of design in city planning
Determining placement of elements of city so they are visually pleasing

SIGNIFICANT IDEA The natural and built environment affect us and our lives each day. People have control over much of the built environment and can structure it to suit their physical and aesthetic needs.

In the past, many cities have often "just grown" with little emphasis on the wise use of resources or design. Now, more often, city planners, architects, and designers employ the elements of art and principles of design when planning the construction of roads, buildings, parks, etc. within our cities. Wise planning helps preserve and conserve our resources so they are used in a more efficient and visually pleasing way.

TIME ALLOCATION 3 or 4 45 minutes lessons

SAMPLE QUESTIONING STRATEGY

- Ask learners to look closely at the photographs and art reproductions for information which depicts positive and negative components of cities.
- List and define necessary basic components of a city.
- What do you remember seeing around our city which has impressed you either positively or negatively? (Newly constructed roads, buildings, landfill, parks by river, flowers on median strips of highways, garbage-filled alleys, etc.) How do you think the site could have been improved? Encourage visual recall.
- Review elements of art and principles of design related to city planning.

- In creating a model city, how would you plan for the space you need? How would you compute the area of land you need for a school, a house, a building? How would you compute the perimeter of a yard, a parking lot, or a park you want to fence in? How much fencing will you need? How would you determine how long the road around a city block needs to be? How will you lay out the roads? How will you determine the contained space you need for your houses, school, office buildings, hospitals, etc.? How will you compute the volume of these structures?

- Encourage use of imagination in planning city design.

RESOURCES

Photographs of your city showing both positive and negative aspects

Photographs or models of plans for airport, shopping center, schools, parks, etc.

Reproductions of artwork depicting cities (examples may include Stuart Davis' Town Square, John Sloan's Backyards, Greenwich Village.

Photos of building by architects such as Frank Lloyd Wright, I.M. Pei.

MODEL LESSON DESIGN

FOCUS ACTIVITY (approximately 3-5 minutes)

Display photographs and models of components of city. Involve learners in discussion about elements of art and principles of design as they relate to city planning.

Vocabulary - natural and built environment, architect, city planning, area, perimeter, volume. Write on board and discuss.

INSTRUCTIONAL OBJECTIVE

The learner will construct a model of a city and compute area, perimeter, and volume as it relates to the use of space within the model.

Virginia Standard of Learning

Art 4.2 The student will use past experiences and simulated situations as subject matter for artwork.

Art 5.9 The student will produce artwork emphasizing one or more of the elements of design.

Art 5.10 The student will describe the contribution of artists and designers to the American heritage.

Math 6.18 The student will find the perimeter of a square and a rectangle using addition.

Math 6.19 The student will determine the number of square units in a rectangular region, given an appropriate drawing.

Math 8.18 The student will find the volume of a right rectangular solid.

EXPLANATION (approximately 7-10 minutes)

Today we are going to begin a project that will take several art periods to complete. Each period we will learn new information which will help us to create a finished model of a city. You will be allowed to work with a partner because the project is a long one and you will need additional hands and ideas other than your own to complete it. Also city planners do not work completely alone. They must work with other planners, architects, city officials, citizens, etc.

in order to design components of the city which will serve the needs of all citizens.

You will receive a plat of land (a sheet of tagboard) which encompasses a section of land within the city limits. On that land you will design the layout of the roads, blocks which contain buildings, parks, etc. which you want in your miniature city. You will compute the area you need for each city block today. Parks may need more land than a school; a school will use more land than houses, etc. We will simplify measuring by using "units" so we will not have to worry about inches, feet, miles, etc. A road is a unit wide. You will determine how many units long it needs to be. A house is a unit square. You will determine how much "yard" you need to place it on.

Teacher teaches or reviews formula for determining area (length x width - in this case using "units"). Teacher demonstrates the process. First determine the area of the plat of land using "units". Then demonstrate how to compute the area of different spaces. Example: My house is one unit square. I want a nice yard around it. I will make my yard 2 units long and 2 units wide. How much of my plat of land will that use? (2 units x 2 units = 4 square units) If I make the area of my yard 2 units by 2 units I will use 4 square units of my area of land.

Demonstrate computing area of additional blocks of land. Involve learners in computation to assess their understanding of the process. Demonstrate gluing down areas of "land" for parks, schools, houses, etc. Demonstrate gluing down construction paper strips for road.

Learners work with partners to complete the layout of their plat of land. Learners may work alone.

LEARNER SUMMARIZATION

The learners will display their layout of the plat of land and point out the land areas they have computed for the buildings, etc. which they will add at a later time.

MATERIALS

pencil
ruler with unit markings (made by teacher)
scissors
glue
construction paper
tagboard (12" x 18")

MODEL LESSON DESIGN

FOCUS ACTIVITY (approximately 3-5 minutes)

Display models of components of city. Review elements of previous lesson on city planning with learners.

INSTRUCTIONAL OBJECTIVE

Same as previous lesson. This lesson will focus on perimeter.

EXPLANATION (approximately 7-10 minutes)

Today we will continue our project on city planning. Last time you measured and computed the area of land you would need for various parts of your miniature city. Let's review how we determined that area. (Review work from last lesson.)

As your city begins to take shape, you may find that you have areas which you need to enclose for one reason or another. You may have a dog you want to keep fenced in a yard. You may have a schoolyard or a park you want to fence in to keep people and traffic separated. You may need to determine how long a road you will need to pave around your city blocks. Now we are going to learn to compute (measure) the length of fencing or roadway you will need to enclose certain parts of your construction. Imagine that the perimeter is an imaginary line which goes around a shape. Draw a rectangle on the board. Redraw around it with a different color of chalk to demonstrate "distance around".

Teacher teaches or reviews formula for determining perimeter (length + width + length + width - in this case using "units"). Teacher demonstrates the process. First determine the perimeter of a city block using "units". Then demonstrate how to compute perimeter of different spaces. Example: My house is located in a nice yard. The yard is 2 units long and 2 units wide. I need to fence in the yard for my dog. In order for my fence to go all the way around my yard, I need to compute the perimeter (distance around) my entire yard. I add the length (2) + width (2) + length (2) + width (2) = 8 units. So my fence will be 8 units long.

Demonstrate computing perimeter of additional enclosed spaces. Involve learners in computation to assess their understanding of the process.

Learners work with partners to enclose parts of the city with fences or to place roads around areas of land.

LEARNER SUMMARIZATION

The learners will display their layout of the plat of land and point out the land areas they have enclosed with fencing and roads. They will describe how they determined the perimeter of the certain spaces using the formula for computing perimeter.

MATERIALS

pencil
ruler with unit markings (made by teacher)
scissors
glue
construction paper
markers or crayons

MODEL LESSON DESIGN

FOCUS ACTIVITY (approximately 3-5 minutes)

Display models of components of city. Review elements of previous lessons on city planning with learners.

INSTRUCTIONAL OBJECTIVE

Same as previous lessons. This lesson will focus on volume.

EXPLANATION (approximately 7-10 minutes)

Today we will continue our project on city planning. In the last two lessons you measured and computed the area and perimeter of spaces that you have in your miniature city. Let's review how you determined area and perimeter. (Review work from first two lessons.)

Your city will really begin to take shape today as you add buildings (paper cubes) to your city. You will learn to construct individual paper cubes which you will combine to form different sized buildings. You will also learn to compute the volume of these forms. A house will be one cube. If you want to make a school, you will need to determine how big it needs to be. Think about how much space the school will need to contain. Do you want it to be one story high or will you make it several stories (cubes) high? Will an apartment building be smaller or larger than the school? In order to compute the enclosed space you want, you will need to use the formula for computing volume.

Teacher teaches or reviews formula for determining volume (length x width x height - in this case using "units"). Teacher demonstrates the process. First determine the volume of a house using "units". Then demonstrate how to compute the volume of different "buildings". Keep it simple. Example: My school is a small elementary school. I have decided to make it 2 cubes long, 1 cube wide, and 3 cubes high. Show example using large cubes. Demonstrate how to compute volume of structure using formula (2 x 1 x 3 = 6 cubic units). Takes cubes apart and add them to show students that formula "works."

Demonstrate other simple examples. Involve learners in computation to assess their understanding of the process.

After learners are able to compute volume, demonstrate how to construct paper cubes.

Learners work with partners to construct cubes. Learners compute volume of buildings they construct with cubes. Learners draw on buildings with markers to make houses, schools, stores, apartment buildings, office buildings, hospitals, etc. Learners glue buildings in place and add sidewalks, bushes, etc. to complete their models. (This will take more than one 45 minute lesson to complete.)

LEARNER SUMMARIZATION

The learners will display their model cities and point out the space their buildings contain (volume) and discuss how it was determined using the formula.

MATERIALS

pencil
ruler with unit markings (made by teacher)
scissors
glue
tape
construction paper
colored duplicator paper 4" x 4" for paper cubes
preconstructed cubes
markers